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RADIUM

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VOL. V AUGUST, 1915 No. 5

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A MONTHLY JOURNAL DEVOTED TO THE CHEMISTRY PHYSICS AND THERAPEUTICS OF RADIUM AND RADIO-ACTIVE SUBSTANCES

RADIUM

A MONTHLY JOURNAL DEVOTED TO THE CHEMISTRY, PHYSICS AND THERAPEUTICS OF RADIUM AND RADIO-ACTIVE SUBSTANCES.

Edited and Published by Charles H. Viol, Ph. D., and William H. Cameron, M. D. with the assistance of collaborators working in the fields of Radiochemistry, Radioactivity and Radiumtherapy.

Subscription $2.50 per year, or 25 cents per copy in the United States and Canada in all other countries $3.75 per year.

Address all communications to the Editors, Forbes and Meyran Avenues, Pittsburgh, Pa.

VOL. V. AUGUST, 1915 No. 5

CANCER DESTRUCTION BY RADIUM.[1]

BY JOSEPH BISSELL, M. D. F.A.C.S., NEW YORK.
Visiting Surgeon, Bellevue and St. Vincent's Hospitals.

By the word destruction is meant local removal of a neoplasm, in contradistinction to cure, the term cure meaning complete and permanent effacement of the malignant growth and its non-recurrence in any other part of the patient. The word cancer in this paper is used in its generic sense and covers all malignant growths. The rationale of the complete removal of a tumor by radium application can be satisfactorily demonstrated only by a thorough microscopical examination of the involved tissues, carried out from time to time during the active treatment and after its completion. In this way the histological changes in the cells, morbid as well as normal, may be anatomically demonstrated and the actual effects of radiation upon these new growths, as well as upon the surrounding structures, may be accurately ascertained beyond question and in a definite manner.

Often, however, for good and sufficient reasons apparent to all of us, it is impossible to make these observations. We then have to depend upon the findings as exhibited by the clinical and objective symptoms.

A considerable amount of evidence is on record, from the writings of some of the best modern pathologists, which shows the structure alterations taking place during the application of radium. To quote only a few authorities:

Gauss describes the histological changes observed in ten pieces of tissue excised at various periods in a case where myomata were under treatment by radiation. Striking changes are shown: At the beginning a microscopical section shows adenocarcinoma; two weeks later a

[1]Surgery, Gynecology and Obstetrics, Vol. 21, pp. 98-102, July, 1915. Read at the annual meeting of the Medical Society of the State of New York, Buffalo, April 27, 1915.

section in the same location shows connective-tissue and cancer nests; three weeks later still, the cancer evidences have disappeared and the microscope discloses nothing except benign tissue with epithelial débris.

Degrais and Bellot pointed out, in a recent publication, that when epitheliomatous cells are exposed to radium there is hypertrophy of the nucleus and degeneration of the protoplasm, together with a certain amount of keratinization. "This process was continued, and twenty days or so after radiation these epitheliomatous masses became transformed into keratinized débris. The formed elements break up and disintegrate; young fibroblasts and connective-tissue cells, lymphatic cells, and polymorphonuclear cells infiltrate the growth and carry on a phagocytic function, and meanwhile cicatrization occurs at the expense of the hyperlastic and regenerated stroma of the tumor."

In a case reported by Aikins, of Toronto, a bone tumor involving the right tibia was removed January 6, 1914, and examined. The pathological examination showed that it was a myeloid and round-celled sarcoma. Three weeks after radium treatment a portion of tissue was removed from the original location for further examination. The pathological report is as follows:

"The tissue examined consists of a portion of large fungating growth removed from the anterior portion of the thigh.

"The epidermal elements have completely disappeared and their places have been taken by a large fungating tumor which clinically is sarcomatous. On microscopical examination one sees that this is a sarcoma with very large cells and a few spindle cells. The sarcomatous tissue infiltrates all through it, there is no tissue reaction, but a connective-tissue stroma is present which is œdematous and filled with a pigment which is evidently haemosiderin. The nuclei are often very large. The size varies, but everywhere it shows mitotic figures and conforms to all the characteristics of malignant sarcomata.

"On June 4 the tumor was exposed continuously to the radium rays, a dosage of 240 centigram hours being given, and on June 15 another portion was removed.

"Here we see wonderful changes. In place of the sarcomatous fungating tumor we find a structure much reduced in size. The large cells of the growth under the influence of the rays have changed to smaller connective-tissue and spindle cells. The cells show necrosis and necrobiosis. The connective-tissue cells have been mobilized and the leucocytic infiltration is most intense, due doubtless to the trophic stimulus. The connective tissue has been vascularized, not by a mere inflammatory reaction, but by a truly specific stimulus, which has expressed itself in the defininte form of connective-tissue elements."

Another evidence of the histological changes produced by radium rays upon cancer-cells is shown in the case reported by Drs. Aikins and Simon, of Toronto, in the *Dominion Medical Monthly*, September, 1914. This patient twelve years previously had the right breast removed for carcinoma. In March, 1914, a recurrence was noted in the left breast. It consisted of a hard mass of induration about one and a half inches in diameter. The nipple was retracted and glands were present in the axilla, together with other typical symptoms of carcinoma. Radium was applied several times by a capable expert, and at the end of the month of May the breast was removed. The following is the pathologist's report:

"A specimen of what proved to be an adenocarcinoma of the breast was submitted to us after being subjected to the influence of radium. We found the upper portion of the skin which previously had been reported to be infiltrated with the growth to be totally free from any remains of malignant tissue. Deeper in the tissue, however, there seemed to have survived a diffuse growth, the cells being smaller as we neared the surface. These cells would also have been destroyed had radiation been continued.

"Some of the carcinomatous cells were markedly hypertrophied, some were monstrous, some vegetative, while the protoplasm showed marked eosinophilia, proving beginning degeneration. The various tissue elements had become broken up and eosinophilic; young fibroblasts had evidently replaced the growth in the parts nearer the surface."

Dominici and Barcat examined a specimen from healed radium burns. The tissues were composed of fibroblasts and connective-tissue bundles parallel to each other and parallel to the surface of the skin. The fixed cells became rarified, the chromoplasm of the parenchymal cell had disappeared and was changed into hyaloplasm. They noted that the connective-tissue bundles separated and the fibroblasts became thickened. These observers also discovered that those portions of the tissue which had been subjected to radium became essentially differentiated from those not within the radium field. All tissue-cells are affected by the rays. The cells of the neoplasm are especially susceptible. As a general rule the more vicious the cell the greater the effect upon it of the ray. Normal tissue-cells are injured, but where they are in close relation with cancer-cells it was discovered that before they are hurt beyond recovery the cells of malignant growths are either destroyed or so changed that normal, healthy structure is substituted. Normal cells appear to have a greater resistance or a lesser susceptibility and are not so easily influenced by radiation. They recover more quickly after injury while the cancer-cells so affected recover their activity slowly or not at all, being often replaced instead by normal connective tissue. This is the so-called selective action.

The conclusions drawn by Teitschlaender,* of Vienna, after repeated pathological examinations of malignant tissue exposed to radium applications are as follows: "The chief action seems to be the inhibition of karyokinesis and activation of leucocytes and destructive changes, allowing the abnormal tissues to degenerate."

In sarcomata the retrogression takes place according to the following law:

1. The size of the body and the nuclei of the large cells decrease.
2. As they shrink the neoplastic elements elongate, but the shape of the nucleus becomes regular, and they eventually assume the form of large embryonic connective-tissue cells, forming into a celled mass similar to that of a true fibroma. Thus we may emphasize the fact that sarcomata are transformed by radium into a tissue analogous to that of a fibroma with myxomatous changes.

As regards epitheliomata and carcinomata under the influence of the radium rays, we find that—

1. The cells gradually diminish in size and staining properties.
2. This atrophy corresponds, not to the metamorphosis of those definite, formed elements, but to their destruction, as shown by keratinization or absorption.

The epitheliomatous cells disappear either by means of progressive

*Monatschr. f. Geburtsh. u. Gynak.., 1913, xxxviii, 296.

absorption of protoplasm and nuclei through the leucocytic infiltration or by a sort of granular degeneration.

The other processes associated with the development of every epithelial tumor are arrested, while vascular connective tissue is reorganized according to the method just described.

As proof that the changes initiated by radium are such as lead to immunity, great importance must be attached to the cellular infiltration first leucocytic, then later a round-celled infiltration. It has recently been shown these activities require different reactions of the tissue for their function; hence radium must affect the blood. These infiltrations have always been noted in all cases of animal experimental transplantation of malignant cells and always accompany the cases in which the animal becomes immune and the tumor disintegrated.

The pathological evidences of chemical, histological, and anatomical alterations in morbid and normal tissues from the effect of radium applications seems, therefore, to be abundant, substantial, exact, and incontrovertible. The clinical proofs of this action of radium are illustrated in the following cases. For the purpose of this paper those only have been selected in which the tumors have been proved by pathological examination to be malignant and in which, under treatment, the growth has disappeared.

CASE 1. J. S.; farmer; age 61; March 21, 1914. Patient has basal-celled epithelioma of the neck, recurrent. Has an extensive and deep ulceration extending from the root of the ear down the neck. Part of the lobe of the ear is destroyed. The ulcerated surface is about three by two and a half inches in extent. The large vessels of the neck are exposed. Besides two previous operations the ulcer has been recently thoroughly cauterized. Forty milligrams of radium applied for 9 hours. April 10, 40 mg. of radium applied for 9 hours. April 16, 40 mg. of radium applied for 9 hours. April 23, the lobe of the ear is entirely healed and covered over with new skin, and the ulcer is reduced to about half an inch in diameter, which is healing in rapidly. Forty milligrams of radium applied for 12 hours, and the patient left for his home the next day, writing me at the end of two months that the ulcer was entirely healed and that there was no further use for dressings. He received in all 1,560 mg. hours of radium in the course of his treatment.

CASE 2. J. F. F.; storekeeper; age 57; October 9, 1914. Patient has a lump about the size of a small orange involving the upper part of the sternum at its junction with the clavicle extending posteriorly into the mediastinum and externally into the right cervical region. Three weeks previously a tumor of this size had been removed by operation and the wound had healed kindly and rapidly. Recurrence began about a week afterward. Pathological report as to tumor was that it was a carcinoma. Today 101 mg. was applied, properly screened, over the region and allowed to remain for 20 hours, patient going to his home in the country next day. October 16, he returned complaining of a slight burning of his skin, but with the tumor reduced to about half its size. October 29, skin is still very tender, but the tumor has almost entirely disappeared. November 12, very slight evidence of tumor remaining, but he has two well-marked radium burns; one rather deep eschar about an inch in diameter and another about half an inch in diameter, both painful and discharging—one to the right and the other to the left of the upper border of the sternum. December 10, the two

sides of the sternum and each clavicle in the sternum region appear to be similar and normal. No evidence whatever of any tumor. The skin is still tender over the burned regions. Patient discharged. One radium application of 2,020 mg. hours.

CASE 3. Mrs. S.; age 40; housewife; seen Septemebr 10, 1914. History of carcinoma of the breast of two years' standing. Breast removed November 10, 1913. Small nodules scattered around the wound and in the surrounding skin; recurred in May, 1914. The pathologist's report was adenocarcinoma of the right breast. At this date 101 mg. of radium applied in divided tubes for 30 hours over a circle of about six inches in diameter. October 1, well-marked radium burns present, but healing; some of the nodules have disappeared, but as the induration along the wound is still marked another application of radium was advised but refused on account of the burns. November 2, radium burns still present but slowly improving. A number of new-skin nodules have appeared outside the circumference of the others. One hundred and one milligrams of radium applied for 15 hours. December 6, radium burns still severe. One large burn on her side over a recent nodule is very deep and troublesome and is about an inch and a half in diameter, excavated and quite painful. One hundred and one milligrams of radium applied for 9 hours, changing the location of the application every hour. December 19, condition about the same except that some of the burns are healed. There are present at least a hundred nodules, some of them quite large. One hundred and one milligrams of radium applied for 22 hours, changing the site of the application every two hours. The radium was screened by 8 mm. of felt as well as by 0.5 mm. of lead. December 23, nodules are slowly disappearing and only one of the large ones remain. February 5, 1915, patient is improving. Most of the burns have healed. The large burn posteriorly is still present, but the induration underneath it has gone, as have apparently most of the other nodules. Patient's general condition is very much improved. She has increased in weight, has better color and appetite, sleeps well, and is quite contented with her condition. One hundred and one milligrams applied to various parts of the lesion for 20 hours. April 15, patient has had two applications of radium of 101 mg. for 20 hours each time since the last note. The nodules have all disappeared except two or three suspicious spots in place of the hundred and more indurations she had when the treatment began. Two small radium burns still persist. Ninety milligrams of radium applied for 20 hours to the suspicious points. In her treatment this patient received in all 15,536 mg. hours.

CASE 4. Madame L. D.; age 69; occupation, governess. Patient gave a history of having had a laparotomy for removal of a tumor of the uterus seven years ago. Six months previous to my seeing her she had a tumor removed from her back, which the pathologist reported to be a round-cell sarcoma. One month later recurrence took place. On admission to the hospital, at the site of a scar over the border of the left scapular spine, at its inner extremity, was seen a small ulcerated growth with characteristic odor. This, the patient stated, had been present for about two weeks. On February 26, 1914, this growth was removed together with the remaining scar-tissue. This was reported by the pathologist to be sarcoma. The operation wound healed kindly, but on March 10, as there seemed to be some tendency to infiltration of the skin at this point, 40 mg. of radium element were applied for 2 hours. After the first application there was no further discharge; the

induration and slight tendency to ulceration which had been present disappeared; there was no further pain or irritation of any kind, and the site of the operation wound was apparently normal except for a white scar line. Examination on May 10 showed no evidence of any return of the growth, but 40 mg. of radium were again applied for 2 hours. April 10, 1915, there was no return of the growth. This patient received in all 160 mg. hours.

CASE 5. J. McE.; age, 55; occupation, waiter; August 27, 1914. Twelve days ago the patient first noticed a tiny abrasion inside the lower lip to the right of the middle. On September 30 this had increased to the size of a large pea. October 20, the whole lesion was excised and the wound sutured. The pathologist's report was sarcoma. October 21, 20 mg. of radium in two tubes were applied for 1 hour. October 23, the wound appeared entirely healed and stitches were removed. October 29, lip was apparently normal. Incision had healed by first intention. Thirty-six milligrams applied for 30 minutes. November 12, 20 mg. were applied to the inner surface of the lip and 26 mg. to the outer, over the line of the incision, for 40 minutes. December 10, 20 mg. in two tubes applied for 40 minutes. The line of incision has practically disappeared. There has been at no time any local reaction. April 5, up to date there has been no return of the tumor. This patient had 81 mg. hours.

CASE 6. Rev. C. McC.; age, 70; occupation, ecclesiastic; December 26, 1914. This patient has growth in front of left ear, raised three-quarters of an inch above skin surface and about one-half inch in its longest direction by three-eights of an inch in width, with superficial ulceration. This tumor has been growing for several months. Without removal 10 mg. of radium was applied for 20 minutes. December 30, no apparent reaction of the skin or tumor. The growth was removed with curved scissors under local anæsthesia and immediately afterwards 50 mg. of radium was applied to the excavated base. Examination proved it to be epithelioma. January 27: Since the removal of the growth he has made weekly visits and 10 mg. of radium have been applied each time for 10 minutes. February 8, growth seemed to be slightly filling in from the bottom. Twenty-five milligrams of radium were applied for 10 minutes. March 10, up to date 10 mg. of radium for 10 minutes each visit have been applied for four visits since the last report. The ulcer has been completely destroyed and new skin is running in from the edges. There is no evidence of radium burn. April 6, patient called for observation. There is no change in the condition. Patient was told to return in a couple of months to see if further treatment was necessary. April 11: He died this morning of a sudden attack of pneumonia. In all this patient had 3,200 mg. hours treatment.

CASE 7. F. W.; age, 16; school girl; March 17, 1914. Patient has suffered for several months from enlargement of the left lower jaw and adjoining lymphatic glands. Pathological examination of one of the glands showed it to be sarcomatous tissue of spindle-celled variety. Forty milligrams of radium applied in divided doses for 4 hours. March 20, no local reaction from the preceding treatment; the swelling of glands and jaw was markedly lessened; 40 mg. of radium again applied for 4 hours. Two weeks later the patient appeared to have entirely recovered. There was no irritation or redness of the skin over the tumors. April 17, 1915, the patient's mother reports that patient is entirely well. She had 320 mg. hours.

CASE 8. F. C.; age, 42; occupation, broker; October 17, 1914.

Patient has epithelioma of the floor of the mouth involving the lower jaw at the median line. This tumor was removed and the pathological report confirmed the diagnosis. October 22, 45 mg. of radium applied for 10 hours in divided doses to the inside and outside of the jaw, one tube of 25 mg. being applied 10 hours under the tongue close to the median line. October 29, under surface of the tongue somewhat inflamed and tender. Ten milligrams of radium, well screened, applied to the under surface of the tongue at affected point and 51 mg. to the under surface of the chin for 4 hours. November 12, no return of the tumor noticed, but there is a slight tenderness and superficial swelling at the root of the tongue behind the teeth, at the site of the cicatrix. Skin on the under surface of the chin is red, tender, and scaling. No radium applied on account of tendency to burn. February 9, 50 mg. applied for 22 hours to the under surface of the chin. On account of a well-marked burn on the under side of the tongue no radium is applied on the inside of the mouth. April 4, 1915, the radium burns have all disappeared and there is no evidence of any return of the growth. He has a slightly enlarged and tender lump in the middle line behind the prominence of the chin. Seventy-one milligrams of radium applied to this point for 8 hours. This patient had in all 2,362 mg. hours of treatment.

CASE 9. J. W.; 51; occupation, ship's carpenter. This patient had epithelioma of the eyelid. Eleven years ago he was operated upon for a similar tumor said to be malignant. The present tumor was removed, and pathologist's report showed it to be epithelioma. After excision the wound was united by three stitches, which parted on the third day, leaving a gaping wound. This was resutured, and at the same time 10 mg. of radium were applied for 20 minutes. No evidence of radium burn was noticed from either of these applications. At the end of three weeks from the first operation 10 mg. of radium were applied again for 20 minutes and the patient was discharged. This patient had 6.6 mg. hours' treatment. No recurrence when seen April 20, 1915.

CASE 10. J. S.; age, 58; occupation, farmer; June 20, 1914. He presents himself with a large excavated ulcer of the right base of the tongue extending forward along the right side of the tongue and across the back of the tongue to the left side. The tongue is badly swollen; saliva is excessive; great difficulty in masticating, and it is almost impossible to swallow food or saliva. The whole tongue is exceedingly painful. The submaxillary and cervical glands of the right side are swollen and tender. He has lost about 40 pounds in the past five weeks; is unable to sleep from the pain; cannot take nourishment except in very small quantities, and is practically unable to swallow or breathe with comfort, lying down. His whole condition is pitiable. The tissue taken from the ulcerated edges of the sore by pathologists in his home town has been reported as epithelioma. One hundred and one milligrams of radium in four separate tubes with two mm. of lead screen applied well back on the right side of the tongue and covering part of the ulceration, for 10 hours; 5 mg. of radium also applied over submaxillary glands and changed from time to time. At the end of 24 hours the patient was discharged to go home to the country with the request to return in September. On August 25, the patient returned for observation. The ulceration at the back of the tongue had cicatrized; the swelling of the glands had disappeared; enlarged glands could no longer be made out in neck; the patient had increased 20 pounds in weight and was able to masticate and swallow any kind of food; extra secretion of

saliva had ceased. Patient considered himself cured. Curiously enough he had a radium burn on the tip of the right side of the tongue, which he said was very much better than a few weeks ago and was evidently healing. In all he had 1,908 mg. hours of treatment.

CASE 11. Miss A.; age 32; occupation, clerk. Entire breast and axillary contents removed on February 15, 1914. Reported as adenocarcinoma. October 20, small nodules which had appeared in scar removed. November 21, several new, small indurations have appeared in the scar around it. The largest is the size of an almond. Thirty-five milligrams of radium were applied to the most prominent lumps for 12 hours. December 22, marked radium burn over site of larger tumor, which is nearly gone. The smaller one has disappeared, but a number of new small nodules, the size of rice seeds, are present. One hundred and one milligrams of radium applied for 22 hours.

These cases, although few in number, represent a variety of malignant tumors, all of which are susceptible of removal by use of radium. They do not by any manner of means represent the large number of patients afflicted with cancer of various stages and conditions where the degree of the disease and complications are such that our present knowledge and experience do not permit us to encourage them to hope for a cure by means of operative procedures, the use of radium, sera, vaccines, or any other known anticancerous therapy. None of the above-reported cases are claimed to be cures. Time enough has not elapsed for such a claim, but as we learn more of the action of radium it is believed that more of the cancer cases which are looked upon as hopeless at present may be relieved by radium alone or by a proper collaboration of radium with the various other remedies at our disposal. In spite of the great advance recently in the methods and technique in using radium, there is still much to be learned. The amount needed depends upon the different purposes of application, the different depths of tissue to be affected, the variety of tissue, the degree of malignancy, its stage, the length of time of application, and many other factors still to be settled. All these indications can be defined only after much experimentation, long continued, together with a proper appreciation of our rapidly accumulating pathological knowledge of the action of this powerful remedy on living tissues.

Many phases are developed during the course of radium treatment. Certain cases of malignant growths yield rapidly to small quantities of the remedy; on the other hand, others are stimulated apparently by small doses. Some skins are extremely sensitive to very small quantities of radium. Other patients have skin which is not affected at all by large quantities continuously applied and frequently repeated, without regard to the protection supposed to be given by screening.

Curiously, exactly similar cases of malignant growths rayed exactly the same way, with the same amount of screening, the same length of time of application, in persons of as near as possible the same age and period of time of tumor, and where the previous operative treatment was similar, may and do give exactly opposite results. For example, Cases 3 and 11 were precisely similar to another case not reported here, where the recurrent nodules persisted and increased in spite of similar treatment in every way. The pathological report was the same; recurrence took place in the same manner, but after one 15-hour application of 100 mg. she went from bad to worse and died in a few weeks. My feeling is that one application was not sufficient and that

in spite of apparent failure the treatment should have been persisted in.

To the lay mind a very serious complication is the burn which sometimes follows the application. This may be extensive and deep and at times very painful and difficult of cure.

Some of my patients have noticed the more rapid disappearance of portions of the growth under the burned area than under that portion unaffected in this manner. These patients sometimes ask to have the radium left on long enough to produce an eschar, believing this to hasten the cure.

The closer the radium to the object the greater the effect of the rays. As the rays shoot out in every direction from the center the ideal course of treatment would be to have the radium as nearly as possible in the middle of the tumor. Therefore a malignant growth in one of the normal tubes of the body and within reach of radium application—as for instance, in the œsophagus, or the rectum—is theoretically much more susceptible to treatment, especially if the malignant growth surrounds the canal than where the neoplasm can be radiated from one surface only. If there is a sinus running to or through the tumor, or if it is in a location where it can be pierced to accomodate the insertion of the radium, satisfactory treatment can also be carried on. When neither of these methods is possible, we have to resort to what is called cross-raying or cross-firing. In this means of treatment we divide the radium into capsules and place it on the opposite sides of the growth, protecting the skin from the burning rays as much as possible by means of screens of different thickness. All these details are matters of technique and depend upon the individual patient and the disease as well as upon the experience of the operator and upon his personal equation.

So little is yet known of the action of radium on living tissues and so much is still to be learned that, working as hard as one can and despite the vast amount of material, even with an ample quantity of radium, it may still be years before a proper and successful method of treatment applicable to each individual tumor can be satisfactorily and efficiently worked out.

Here are twelve patients with new growths, pathologically and clinically malignant. These neoplasm have disappeared during radium applications. Following their destruction or removal the tissue at the former site of these tumors is now normal and remains so. Certain these results merit our further careful consideration.

RADIUM IN THE TREATMENT OF KELOIDS*

FRANK E. SIMPSON, M. D., CHICAGO.

The introduction of radium furnishes us with a therapeutic agent of great value in the treatment of keloids. Unfortunately, one is not always able clinically to differentiate pure keloids from those mixed with scar tissue.

Pure keloids, especially those of recent formation and in young children can often be resolved with " selective" doses of radium rays,

*Journal of the American Medical Association, Vol. 64, pp. 1300-1, 1915.

that is, with an amount of raying that causes little or no inflammatory reaction.

Keloids mixed with scar tissue are more resistant to radium, but even these can generally be made to disappear by using doses that cause more or less destructive action.

The exact dose necessary in individual cases is difficult to state, but after some experience with different radium applicators is obtained, an

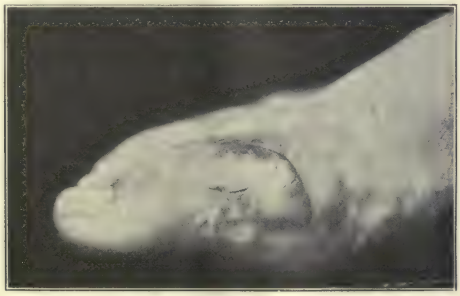

Fig. 1.—Keloid following burn on right great toe. From photograph taken May 27, 1914.

approximate estimate of the amount of raying necessary can often be given, especially if the clinical type of keloid is clear.

Pain, which often radiates from the keloid, is usually relieved at the same time with the resolution of the tumor. This is fortunate as it is often pain, which may be of an excruciating character, that brings the patient for relief. Sometimes relief is sought for cosmetic reasons alone, and sometimes because the keloid is in an inconvenient situation.

In upwards of a dozen keloids of various types which I have treated with radium, the results have been superior to those obtained by other methods.

The apparatus and technic employed vary somewhat with the type of lesion. With keloid of considerable size, the varnish applicator is by far the best instrument to use. For linear keloids, such as may follow an operation incision, the radium tubes are very convenient, although the varnish applicators can be used by screening off the healthy tissue on each side of the keloid.

Fig. 2.—Appearance of toe shown in Figure 1, after above twelve hours' radium treatment. From photograph taken Jan. 30, 1915.

In practice the theoretic use of purely selective doses, which may cause the keloid to disappear, must often give way to the more rapid method of destructive doses. The general principle of using a sufficient

dose to produce a slight but not an excessive reaction is the one I usually follow. Repeated and strong reactions are usually unnecessary and are liable to be followed by telangiectases, which detract very much from the cosmetic appearance of the tissues of repair.

In favorable cases the site of the keloid may become almost like the normal skin both in color and texture. In other cases it may be smooth and white and sometimes it may be redder than normal. In no case has there been an absolute resistance to the action of the radium.

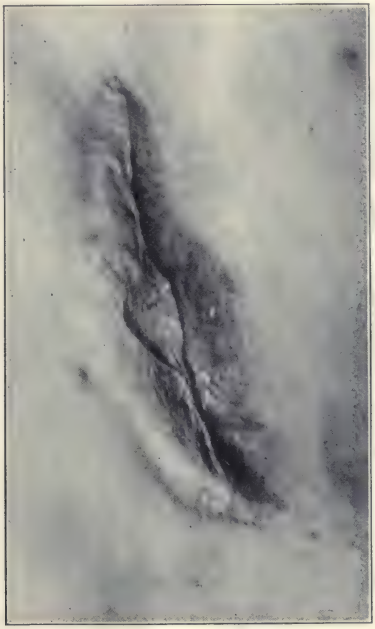

Fig. 3.—Keloid on back situated between the spine and lower angle of right scapula. From photograph taken April 4, 1914.

A brief history of the following illustrative cases will show the method of treatment and the results obtained.

CASE I. (Referred by Dr. J. R. Buchbinder.) In a girl, aged 15, a keloid developed after a carbolic-acid burn near the metatarsophalangeal junction of the right great toe. The keloid, which was of bluish-red color, covered an area of about 4 square centimeters and was elevated about 2 cm. above the level of the surrounding skin. It caused great inconvenience from its situation so that a thick piece of felt fenestrated to admit the keloid was worn to prevent pressure of the shoe. A quarter-strength radium applicator screened with 1-10 mm. of lead was used. Between May 27 and June 4, 1914, this was applied for six hours in fractional doses of an hour each. This series of treatments was repeated in about six weeks. The keloid completely flattened out at the end of four weeks more after having undergone very

slight inflammatory reaction. At present only a slight wrinkling of the skin marks the site, complete involution having persisted.

CASE 2. (From the Chicago Policlinic.) A large keloid on the back between the spine and the lower angle of the left scapula of a woman 45 years of age had followed a burn with a flat iron. The tumor was deep red in color and its surface was traversed by several

Fig. 4.—Appearance of keloid shown in Figure 3, after about six hours' radium treatment. Note removal of lower half of keloid. From photograph taken Sept. 30, 1914.

large venules. It was about 15 cm. long and 4 cm. wide and was elevated about 2 cm. above the general level of the skin. Excruciating burning pain of paroxysmal character was complained of and this had brought the patient for relief. Between April 6 and 22, 1914, eight treatments of twenty minutes each were given to the lower half of the keloid with a quarter-strength radium apparatus unscreened. Moderate reaction followed which subsided in about four weeks. Between May 27 and July 3 certain areas that had not involuted completely were given three hours exposure in fractional doses with quarter-strength and half strength applicators screened with 1-10 mm. of lead. This resulted in complete involution. The pain radiating from the keloid was completely relieved.

59 EAST MADISON STREET.

REVIEWS AND ABSTRACTS

Joseph B. Bissell, M.D., Radium Therapeutics Otherwise Than For Malignancy.—Medical Record, Vol. 87, pp. 1023-4, 1915.

Case reports are given of patients who have been treated and cured by the use of radium. "These are not cases of malignant disease, and it is interesting to realize that radium is available to relieve other than cancerous conditions."

"CASE I.—Mr. J. McC., 43 years of age, has always been a healthy, robust man, workng hard as a laborer. A few days before coming into the hospital he infected his thumb while opening oysters. He states that a piece of oyster shell penetrated under his thumb nail, making a very painful wound. This soon became red and swollen, and the pain and tenderness extended up his arm. On entering my service at Bellevue he presented a typical picture of infection of the thumb and forearm, with an involvement of the metacarpophalangeal joint and ostitis of the bones entering into this joint of the right thumb. There was a severe cellulitis of the surrounding soft parts with abscesses extending up the arm. The disease was treated in the usual way by incisions, irrigations, and wet dressings. At the end of three weeks there were several profusely discharging sinuses about the thenar eminence, and bare bone was felt through these sinuses. An x-ray picture taken at this time, disclosed a badly disorganized joint, and a necrosis of both bones. It was decided by the patient and myself that the best thing to do to get him well quickly was to remove the thumb. Before doing so, however, I decided to try the effect of short time radium applications into the sinuses. Thirty milligrams of radium in three different tubes were inserted into the sinuses leading to the joint. These insertions were made on four different occasions, and the radium was allowed to remain in the sinuses ten minutes each time. The applications were made four or five days apart. Immediately following the first application the discharge decreased, the sinuses contracted, the swelling began to lessen in amount, and at the end of the third application only one sinus remained large enough to insert a tube into. The other two tubes were therefore placed on the outside of the affected part and for the fifth and last application all three tubes were so applied. At the end of two weeks from the beginning of this treatment the infection had entirely disappeared, the thumb was again a solid part of the hand and the patient was able to use it as you see now. Here is a remarkable change from a soft, jelly-like mass of broken down tissues with a foul odor, discharging sinuses, and a painful and useless hand to what is as you see a perfectly comfortable and available organ, although somewhat scarred and stiffened. He uses the thumb now for every purpose for which it was designed. At no time was any dead bone removed or did any come away, although the x-ray picture shows its presence."

CASE II.—Another patient a woman, 35 years old, who suffered from an infection of the foot, due to a compound fracture of the second phalanx of the second toe of her right foot. The injury was so severe and the infection so deep that the toe was amputated at the metatarsophalangeal joint; the infection continued however, and involved the metatarsal bone. At the end of several weeks a sinus remained, extending from the upper surface of the foot to the diseased bone with no tendency to healing. Into this sinus, and alongside the bone, a tube containing ten milligrams of radium was inserted and allowed to re-

main for twenty minutes. Pain, swelling and discharge at once began to disappear, and the sinus to grow smaller, so much so that the next insertion of the tube five days later was quite difficult and almost unnecessary. A week after the original application the patient had entirely recovered and walks without a limp or any evidence of having so recently convalesced from a severe infection."

"CASE III.—Mr. L. M., 28 years old, clerk, has been suffering for the past three years from diabetes. Early in December, 1914, he first noticed pain and swelling of the under surface of the base of the second toe. This gradually became localized into an abscess at this point followed by an ostitis and necrosis of the head of the second metatarsal bone and the adjoining phalanx. February 10th a sinus remaining, and no improvement having taken place in the foot which was now quite decidedly involved in a secondary cellulitis and lymphangitis, the sinus was washed out with a weak solution of radium and 10 milligrams of radium protected by a silver capsule and rubber screen applied for half an hour. Three days later the discharge was much less profuse, and 35 milligrams of radium were applied to this region, 10 milligrams of radium being applied as before into the sinus. Five days later the sinus was so nearly healed that it was impossible to insert the radium capsule. The same quantity of radium was applied in divided doses on both surfaces of the toe and foot near the sinus. Ten days after the first application of radium there were no further evidences of inflammation of the foot or bone, and the patient was out of bed and walking with only a slight limp. His diabetes had been treated dietetically during this surgical attention, and his general improvement was also marked. He was discharged March 10 free from sugar and apparently medically and surgically well."

"CASE IV.—Another case, Mary H., 49 years old, had been treated by me seven years before the present trouble. At that time I had removed a cartilaginous and badly lacerated fibrous cervix uteri. The patient had had no symptoms of any trouble in this respect until six months ago, when she presented herself to my friend, Dr. Baldwin, of this city, because of constant uterine hemorrhage. He treated this with varying degree of success for several months. About six months ago I saw her and put her under an anesthetic for an examination and removal of a piece of the bleeding tissue for microscopical examination. On examination under ether blood could be seen oozing from the stump of the uterus. Curettage was performed rather unsatisfactorily, 75 milligrams of radium was then applied against the curetted point and kept in place by packing for eighteen hours. The packing was removed, irrigations advised, and no further treatment applied. The radium was applied June 25, 1914. There has been no return of bleeding up to date. Following the radium insertion the patient had a very several rectal and vesical tenesmus lasting several weeks, and accompanied by rather profuse and painful vaginal discharge. This I assume was due to a radium burn. The radium in this instance was screened off by a half millimeter of lead and silver, reinforced by another half millimeter of rubber and adhesive plaster covering."

"CASE V.—This lady, 25 years old, unmarried, had been operated upon some six weeks before February 1, 1915, for gallstone. Following their removal the gall-bladder was drained and the biliary sinus is still open. She is suffering now from small abscesses in either axilla. These abscesses are not large, about the size of a small grape, and superficial in depth. They were slow in healing after opening and in that way

troubled her considerably. A ten milligram of radium capsule was placed in the cavity of each abscess for five minutes. The cavity at once began to dry up and in forty-eight hours every abscess so treated closed and remained closed. New abscesses appearing were opened widely, and a ten-milligram radium capsule applied to the cavity for five minutes, with the result that the lesions all healed very rapidly. A course of four or five days of this treatment cured the patient of her tendency to suppuration in this region. No attempt was made to treat the biliary sinus with radium and this finally closed after several weeks' treatment."

"CASE VI. Another case of totally different nature is offered for consideration. Mrs. H., 44 years old, came into the hospital, December 15, 1914, appearing to be in the last stages of pernicious anemia. Her blood picture was as follows: Reds, 1,207,000; whites, 4,400; hemaglobin, 32 per cent.; eosinophiles, 3. Appetite poor, sleep badly broken, suffering from considerable dyspnea. Temperature 100°, pulse 120. Physical examination shows slightly enlarged spleen and great emaciation, weight being about 72 lbs. in a patient of five feet, two and one-half inches. She has a well marked hemic murmur. No signs of any disease of other organs. Repeated examinations of the contents of the bowels showed no ova or any evidence of hook-worm or any other intestinal disease dispite her marked eosinophilia, which at times during her treatment was as high as 14 per cent. This patient was seen by many of my colleagues who concurred in the belief that she was suffering from pernicious anemia. Before coming under my care, and since, she has been treated very thoroughly with various iron tonics and other medication, by dietetic measures, by rest and change of climate and environment, by various sera, and recently by long-continued intermuscular injections of cacodylate of soda. She grew steadily worse, her anemia increasing as well as her weakness until her red blood count was reduced to 1,080,000 and her hemoglobin to 27 per cent. This was early in January, 1915. January 6 she was given intravenously 100 micrograms of radium in solution. This was repeated in eight days. Following this every second day she received an intermuscular injection of one-half a microgram of radium in solution for two weeks and thereafter every third or fourth day for six weeks. The first week in February the patient began to show marked signs of improvement which steadily continued. She now weighs about 100 lbs., has improved in appearance and color, is out of bed and out of doors, eats and sleeps well, and is entirely a different woman in every way. Her hemoglobin is 75 per cent. and her red cells are 3,850,000. The radium injections have been left off for the past two weeks. She has had no medication whatever since March 10."

"These few cases are presented because of the striking results obtained by rather uncommon ways of using radium. Attention is particularly called to the interesting effect of the application of radium in streptococcic bone infection. The cure of pernicious anemia by intravenous injection and intermuscular injection of solutions of radium as seems to be the result in the last case would suggest new opportunities for treatment in this usually fatal disease."

* * * * *

Howard A. Kelly, M.D., The Treatment of Cancer by Radium. Maryland Medical Journal, July, 1915, p. 161. Medical World, July, 1915, pp. 256-7.

"Radium, our newest therapeutic agent, is proving to be of the utmost

value in the treatment of cancer of all kinds, whether operable or inoperable. Two of the three rays emitted by radium, the beta and the gamma rays, affect the tissues of the body most profoundly, fortunately, however, acting much more potently on the weaker cancer cells than upon the normal cells of the body. No one claims and one ever has claimed that radium would cure all cases of cancer—that erroneous statement is due to the daily newspapers, hunting for something dramatic for their columns."

"Radium has, however, won for itself a definite place in cancer therapy, and with time and experience, and above all, with increased amounts of radium and newer methods of applying it, its domain over this dread realm will undoubtedly extend from year to year."

"Radium therapy is analogous to x-ray therapy, with the striking differences that radium is far more potent and is less likely to cause any irritation or injury to the sound tissues. Radium acts more speedily than x-ray; for example, it is the rule to finish the treatment of a fibroid tumor with one or two applications of radium, while many x-ray treatments are called for extending over weeks or even months. I include here under the broad term cancer, sarcomata as well as epithelial growths."

"At first the question was: does radium really cure? But now that query can be answered positively and in the affirmative after the lapse of years. This fundamental matter has also been set at rest by autopsy made years after treatment of inoperable cancer."

"Cancers of the skin are most amenable to radiation. The only obstinate and refractory group of cases here is the cases which have existed for years and which have been treated by cautery, caustics, etc. Those cases are obstinate which have invaded the deeper tissues or which have crept over on to the mucous surfaces. The most obvious advantages of radium are seen in cancers around the eye, the ear, the lips, the nose, where the healing takes place without mutilation, in marked contrast with exsective surgery. Even where there has been extensive ulceration there is often a surprisingly good restoration of form."

"The entire surgical world has been startled by the results secured so rapidly in treating with radium that hitherto hopeless group— the lymphosarcomata. Here great tumors interpenetrating all the anatomic structures even to the base of the skull, the neck or into the chest, literally melt away in a few days' time. The rays act like myriads of microscopic knives attacking every individual invading cell, while sparing normal tissues.

"Many other sarcomata are also helped in a remarkable manner, but not in such a large percentage of the cases. Epitheliomata of the mouth, tonsils and larynx, especially the basal celled, even in totally inoperable conditions, can be cured in a fair percentage of instances."

"A favorable form of cancer is that of the thyroid gland. Thymus growths of the small round-cell type are very amenable to treatment. Lip cancers yield more and more as our experience grows, but the block dissection is always called."

"Nearly all breast tumors respond in some measure, the larger medullary form being the most susceptible. The best rule here is operation first, when feasible, and radiation afterward. Cancer of the vagina usually disappears rapidly under radiation."

"I am glad to report that cancers of the cervix are among the most amenable to radium therapy, and this remarkable statement holds good

not only for the early, but even for the later cases where the disease, tho massive, still remains localized.

"In nearly 30 per cent of the inoperable cases even the disease has disappeared under efficient radiation with large amounts of radium element. This was true in a group of over two hundred cases treated by Dr. C. F.Burnam and myself. It is a common sight to witness, too, the disappearance of a growth recurring in the vaginal vault after operation. It is a question for the next three years to settle, whether we will continue to operate on any of the group of cases which melt down under our radium therapy.

"Up to the present radium has been used repeatedly to shrink an inoperable growth down and then to operate radically.

"Finally, in concluding this brief resume let me say that while radium manifestly ought to replace surgery in many instances, and while it does some of its best work in curing cases which surgery has not the remotest hope of touching, yet, on the whole, there remains a large place for radium combined with surgery, either by following the surgical operation with radiations to reach nests of cells which the surgeon has not been able to eradicate, or to immunize the tissues, or to remove a growth which shrinks, but does not disappear or to treat recurrences. With such a brilliant present who can declare what the future for this new and most potent agent may be? May we not legitimately look forward to a development as great as that we have witnessed in so short a term of years in the field of x-ray therapy and emanations?"

* * * * *

T. Casper Gilchrist, M.D., Cancer of the Skin. Maryland Medical Journal, July, 1915, pp. 157-60.

"The keynote to the whole question of cancer is early diagnosis. If this disease were accompanied by severe pains in its earliest stages, the large majority of patients would undoubtedly be cured by modern methods of treatment. It has been said that there are three stages of the disease: (1) when the patient does not know what is going on, (2) when the family doctor is not sure of his diagnosis and in many cases does not suspect cancer, and (3) waiting to decide what to do after the diagnosis is made by the surgeon or specialist. To correct the first the public ought to be trained to seek the doctor early. To correct the second the doctors during their student course should be better trained in dermatology.

"The definite diagnosis in so far as skin cancers are concerned ought to be made by the dermatologist, and not by the surgeon, because the former is familiar with other affections and the surgeon is not. The majority of practitioners who have come for post-graduate courses in dermatology have generally made the remark that they know less about skin diseases than about any other branch of medicine. The teaching cannot be entirely at fault, because it consists mostly of demonstrations of cases; but a good deal of the weakness of the doctor's knowledge is due to the fact that, instead of attempting to first diagnose the case himself, as he ought to be trained to do, the cases are described and diagnosed by the lecturer, after which the students do not examine the patients thoroughly enough to remember them. Again, enough emphasis is not laid on the frequent demonstrations of the common eruptions, including all the varieties of the early stages of cancer of the skin.

"In my experience, I find that the practitioner more frequently thinks first of lupus vulgaris (tuberculosis) as a possible diagnosis of a chronic

ulcer, especially of the face, whereas that disease is very uncommon as compared with the frequency of cancer or syphilis.

"In commenting upon cancer of the skin, one really cannot do better than present the chief diagnostic points of the various forms of skin cancer and the other common ulcers for which it is mistaken."

"I. *Cancer.* Definition. Cancer is a special new epithelial cell growth which overcomes normal resistance, has a destructive tendency and may form metastases."

"*Epithelioma.* Term usually applied to skin cancers, of which there are two main types: (a) squamous cell, (b) basal cell or rodent. Epithelioma is frequent in middle or old age; usually single lesion; begins in scaly spot, excoriation, fissure, nodule, wart or mole; frequently result of chronic irritation."

"(a) *Squamous cell type*—more malignant variety. Often begins as a pinkish or white skin nodule, growing upward and downward; has an elevated, indurated border; has slight viscid discharge streaked with blood (because bleeds easily); surface nearly always crusted and underneath crust, like coarse granulation tissue; new growth more than ulceration when near surface; slow growth and finally often leads to enlargement of nearest glands; situated usually about eyelids, nose or lips; in early stages no pain, later painful."

"*On Lip.* Any persistent localized thickening or abrasion or fissure of several months' duration is very suspicious of epithelioma. Later lesion consists of raised, irregular, indurated growth with coarsely granular and crusted surface; bleeds easily; nearest glands frequently enlarged; microscopically shows pearl nests, which are absent in rodent ulcer."

"(b) *Rodent Ulcer* (basal cell.) Usually situated about temple, eyelids and nose; superficial; shows very little new growth; apparently healing, then breaking down again; spreads very slowly, with little or no elevated edge; in some stages narrow, pearly-white, roll-like border; ulceration may last years; no glandular enlargement; when invades eye socket, can destroy whole eye; practically painless."

"*Non-ulcerative Form of Rodent.* Has a firm, slightly raised, rolled edge with scarlike atrophic center; very chronic and very slow-growing; section from margin reveals nature of growth."

"*Treatment.* Radium, X-rays, excision when feasible."

"II. *Syphilitic Ulcers.* (a) Primary. When extragenital is most frequent on lip; more often in early adult life; rapid growth; short duration (little tendency to active ulceration); markedly infiltrated; nearest glands soon become very much enlarged; later other symptoms of generalized lues become visible; presence of spirochaeta pallida clinches diagnosis."

"(b) *Late Secondary or Tertiary.* In middle or late life; frequently on face; two types—(1) nodular; one or more pea-sized and larger superficial ulcers in groups; spreads with serpiginous outline; punched out; raw-ham color; soft scarring; indurated. (2) Gummatous; deep; single; markedly punched out; indurated; necrotic base; discharges freely; bad odor; bone may be involved; painful at night; often superficially punched-out soft scars elsewhere; history of lues."

"III. *Lupus Vulgaris.* Commonest form of tuberculosis of skin; rare in United States; begins in early life, rarely after 20 years; peculiar yellowish, large pinhead sized, red, infiltrated macules, points or nodules of soft consistence (probe easily pushed in); most frequent situation on face; very slow course; very chronic; ulcers shallow; scanty discharge; no serpiginous outline; bone rarely involved; scar often dense, thick and tough; often tuberculous history; pressing on margin with glass slide will

show presence of pinhead-sized brownish areas; microscopic sections show tubercules in skin."

"IV. *Blastomycosis.* Begins as pustule or papulo-pustule; later becomes papillomatous with miliary abscesses around the margin; may spread rapidly; raised, rather soft with pus exuding on pressure from between papillae; autoinoculable; often see more than one lesion present; often healing with soft scars. Microscopic examination of pus soaked in liquor potassae will reveal presence of budding doubly-contoured bodies about the size, and larger, of a red blood cell."

"V. *Varicose Ulcers.* Usually on lower third of leg; superficial; irregular in shape according to age; callous edge; surrounded by eczematous, deeply-reddened skin; less pains at night; marked varicose veins."

"VI. *Staphylococci Ulcers. Infected.* Those not due to above causes; follow bad or neglected treatment or secondary infection of eczema, excoriations, slight wounds, vaccination, pustules, infected granulation, etc.; usually superficial; irregular; painful."

"*Epithelioma of the Tongue.* Usually hypertrophic; no ulceration in early stage; follows leukoplakia, syphilis or dental ulcer; as mamillated tumor; irregular; larger at base than apex; surface more villous than normal; later ulcer on deeply ill-defined nodule; everted border; bloody discharge; most frequent on anterior half and edges of tongue; aged 40 to 60 years; glands enlarged; painful salivation."

"*Treatment.* Excision, radium, X-rays."

"If the practitioner is in doubt about the ulcer being syphilitic or malignant, the Wassermann test or internal antisyphilitic treatment will frequently help to clear up the diagnosis. While in doubt about the diagnosis, leave the ulcer alone, or prescribe boric ointment or other mild antiseptic applications. *Do not on any account use silver nitrate or other caustics,* because these usually stimulate the disease and I have seen many cases become very malignant and grow rapidly after such unskillful applications."

FREQUENCY OF CANCER

"In the last 20 years' experience I have come to the conclusion that cancer of the skin has not noticeably increased in frequency, but the efficiency of diagnosis has improved so much that the disease only appears to be more frequent."

"*Treatment.* This varies according to the stage and position of the cancer. During the last six years I have obtained very successful results with the application of radium, especially when the cancer has attacked the lower eyelid, inner or outer canthus of the eye, various parts of the nose or other parts of the face. The resultant scar is hardly noticeable, the application painless, and with proper screening of the radium no unnecessary reaction is produced. All forms of rodent ulcer can undoubtedly be successful treated with radium. I have had 16 years' experience with the use of X-rays in the treatment of skin cancers, and have seen very many cures, the most appropriate cases again being those of the rodent ulcer type."

"The use of the Coolidge tube has simplified the treatment of malignant growths by increased doses of screened X-rays, which need only be given a few times."

"Complete excision of small growths in appropriate places is also good treatment, but surgical procedure is not the proper treatment in beginning epitheliomata of the eyelids and various parts of the nose."

"It is now a moot question whether excision, X-rays or radium is the best treatment for early cancers of the lip. Speaking generally, treat-

ment by X-rays in skilled hands has given as good results as surgical procedure, which has the disadvantage of causing much disfigurement. Radium, which is now being given in more intense doses and screened is now producing excellent results. I have treated numbers of very persistent lesions of lips and tongue, which one could not definitely decide whether they were cancerous or not, but may have been precancerous lesions, with radium with marked success."

* * * * *

"Isotopes. The word "isotope" aroused a good deal of discussion at a recent meeting of the Roentgen Society, when Mr. Alexander Fleck, B.Sc., of Glasgow University, read a paper on the chemistry of the radio-elements. Isotope is a term applied by Professor Soddy to denominate bodies which are chemically identical, although they may differ slightly in atomic weight. The process of radium disintegration, starting from uranium, may proceed through a whole series of elements and arrive finally at the end-product, which is isotopic with lead—that is, which is lead in respect to all its chemical and other properties, but differs slightly from lead in atomic weight. According to the latest determinations, pitchblende lead, the final product of radium, has an atomic weight slightly different from that of ordinary lead, and this difference is not accidental. But the word "isotope" involves the whole theory of the construction of the atom. Rutherford's conception of the atom, said Mr. Fleck, was the only one which recommended itself to the mind of the chemist. It postulated a perfect system within the atom, consisting of an internal nucleus surrounded by a ring of electrons, and it was the positive charge in this atom, together with the structure of the nucleus, which determined the properties of a given element, and its place in the periodic table. In any two isotopic elements, therefore, there would be the same nuclear charge inside the atom of each, and presumably a system of electrons arranged in the same manner. In the course of the discussion Professor Nicholson said that if the chemists were prepared to accept the theory of isotopes, no serious criticism was likely to be forthcoming from the physicists. The point which puzzled him, however, was whether, theoretically, the spectra of a pair of isotopes ought to be identical. The answer depended upon the point of view taken as the origin of spectra. Some writers contended that they were of dynamic origin; others, including Lord Rayleigh, that their origin was kinematical; and, on the latter presumption, a difference in atomic weight, however small, would be expected to produce a difference in the spectrum. Professor A. W. Porter, who considered that the arrangement of the radio-elements in this orderly sequence was the most important generalization made since Mendeléeff, confessed that he preferred the term "isotope" to the more rigid English of the term "chemical identity," because the former was less definite, and might be stretched a little as time went on and the need for some rearrangement of ideas became manifest. Mr. Fleck assured the meeting, however, that when Professor Soddy applied the term "isotope" to these products of radio-disintegration he never thought of using it merely in the sense of strong similarity. Chemical identity—as, for example, between the end product of radium and lead—did not include physical identity, and the atomic weight, being a physical rather than a chemical determination, might vary within considerable limits. It was the positive charge and the nucleus of the atom which determined the properties of a body." British Med. Journ., March 27th, 1915, p. 563.

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Radium Solution for Drinking... ("Standard")	2 Micrograms	2 Microcuries (5,400 Mache Units)
Radium Solution for Intravenous Use (Ampulles) ..... ("Standard")	50 Micrograms	50 Microcuries (135,000 Mache Units)
Radium Solution for Intravenous Use (Ampulles) ..... ("Standard")	100 Micrograms	100 Microcuries (270,000 Mache Units)

40 to 50% of any quantity of radium element, intravenously used, is eliminated in the first 10 days. The remainder is eliminated at a daily rate of less than one per cent. of the radium present, and may be held constant in quantity by administering one bottle of "Standard Radium Solution for Drinking," every two to four days, depending upon the amount of radium first used.

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